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Factors contributed to the poor-quality cost in the XYZ Construction of Transmission Tower Lines

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Abstract

The factors contributing to the cost of poor quality in the XYZ construction company are critical in the construction of transmission tower line foundations. Identifying the delays during the construction process minimises rework by reducing a number of factors, including waste, productivity improvement, communication improvement between the designers, clients and contractors and enhancing customer satisfaction. However, the complexity of the construction projects led to a poor understanding of the lean philosophy within the projects. Furthermore, this study identified the factors, including the construction design issues, Poor quality in construction, Rework, Lack of resources, Engineering design issues, and technical issues that contributed to the cost of poor quality using the archival data from XYZ Construction Company. This study adopted factor analysis to identify the contributing factors to the COPQ. The study's results found that construction site management-related factors contributed to rework due to design-related issues, where the root cause originated from the design phase of the construction project.

Keywords
Construction, Cost factors, Poor Quality Cost, Contributing factors.

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1. Introduction

The South African construction industry plays a crucial role in the South African economy by contributing to infrastructure development and providing economic growth. However, in developing countries, the construction industry faces challenges that reduce profitability and increase project costs. These challenges include rising inflation, declining commodity prices, and fluctuating exchange rates. One of the main challenges is a lack of funding, which affects several aspects of construction projects. Inadequate financial resources limit the project scope and reduce access to high-quality materials, skilled labour, and modern technology (Abdullah et al.2025). However, (Sandandanyake 2022) highlighted activities within the construction industry that have environmental impacts, such as the transportation of materials, the handling process which directly affect emissions. Additionally, the health impact on the community around the construction area due to dust, noise and chemical exposure.

(Olanyika 2015) indicated that the internal contributing factors, such as errors during the construction process, design changes, lack of skills, inspection failures, lack of quality control, inadequate quality checks and design challenges, result in structures' non-compliance, which contributed to the COPQ in the construction industry. According to (Yahya [4] et al.2019) various factors contributed to the cost of poor quality in the Nigerian construction industry, including the design conformance to the specifications, leading to rework and a shortage of material during construction. The International Group of lean introduced the term lean construction in Finland at their first conference (2019). (Maraddzano et al. 2019) indicated that the lean concept originated in Japan between the late 1950s and early 1960s were led by the Engineer Taiichi Ohno, optimising the Toyota Motor Company manufacturing process and waste elimination. The importance of reducing cost in the construction projects improves the construction process efficiency by standardising the process and eliminating construction waste (Maradzano et al.2019)

1.1 Objectives

Analysis of the factors that contributed to the cost related to the poor quality in the construction of Transmission Line Towers.

2. Literature Review

2.1 Review of Lean Construction Theory

The lean construction concept is important in the construction industry and has been applied globally in construction projects and adopted from lean manufacturing to improve the project performance and maximise the project value. However, its application is still limited in countries such as Indonesia, and the implementation process is still not yet structured (Firdaus 2025).In the last century, the lean concept was coined in the Toyota Production System (TPS) in Japan around the early 1970's and moved in writing to the west and the world. The principles for the lean system include: the continuous improvement of work to improve the perfection, Value stream mapping identification, Customer pull, Waste elimination to reduce the delays in the construction process. In the last decades, the fourth industrial revolution in the construction industry has been applied by the management of the construction outcomes and improvement (Balkhy 2021).

The lean concept was introduced to the construction industry in 1992 by Lauri Koskela, who demonstrated that the Transformation-Flow-Value (TFV) theory consists of three central concepts: flow of information and materials, materials inspection to reduce the non-value-added activities, and Transformation for work execution to complete tasks. The lean thinking was successfully implemented in the manufacturing industry in the early 1990s; as a result, the concept was adopted in the construction industry after the successful implementation in the manufacturing industry (Moradi 2023) and (Nsiah 2017).In the past two decades, the manufacturing industry has improved its productivity, performance and efficiency and waste elimination through the application of the lean construction concept (Roxas et al. 2023). Various manufacturing industries implemented lean practice to improve product quality, reduce production delays and eliminate the non-value adding activities for the manufacturing process (Gebeyehu et al.2022).

2.3 Lean construction implementation challenges

Despite the availability of technologies and project control techniques, the construction industry is still experiencing challenges such as rework, delays in project completion due to cost overruns, lack of contract management, financial challenges, lack of skills, shortage of materials, technical issues and design errors (Okinradewo et al.2021) (Table 1).

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Challenge	Affected Lean Principle	Lean Implementation Impact
Cost overruns due to project delays	Pull planning, value and flow	Project inefficiency
Rework	Waste elimination	Project delivery delay and additional cost
Poor Contract Management	Lack of collaboration and transparency	Lack of communication between the project stakeholders results in project scope creep
Financial Challenges	Just in time and cost control	A work stoppage that results in a reduction of the lean investment process
Technical Challenges	Continuous improvement and stability in the construction process	Quality errors and safety risks
Design errors	Value stream map	Construction activities rework
Shortage of Skills	Continuous improvement	Quality inconsistent

(Xing et al.2021) highlights the challenges related to the lean construction implementation, such as insufficient time for implementation, lack of training, lack of alignment in lean implementation requirements, resulting in project delays, project inefficiencies, rework and cost of poor quality. The construction industry in Egypt experiences the lean implementation challenges related to management resistance to change, limited knowledge of lean principles and tools and ineffective communication and coordination between management and contractors (Shaqour 2022) and (Balkhy et al.2021). (Ahmed 2020) ranked the top challenges when implementing lean, such as a lack of skills and awareness, employee negative attitudes, and a lack of equipment, as well as challenges in selecting the right lean tools and resources. The key challenges in lean construction implementation are the resource constraints, old equipment that makes it difficult to implement lean and a lack of technical expertise that results in resistance to change among the senior management. Lean construction implementation is becoming more commonly recognised to reduce production inefficiencies and increase production in developing countries. The Lean construction has been successfully implemented in Asia and the Middle East, and resource utilisation was guaranteed where big construction projects are determined by organisational development (Singh 2025).

2.4 Contributing Factors to the Cost of Poor Quality in the Construction Industry

(Yahya et al.2019), Depict the factors that contributed to Poor Quality Cost in the construction project performance in Table 2.

Table 1 : Contributing Factors in Construction Project

	Contributing Factors
Time Factor	Time-related factors affecting project performance include resource shortages, a lack of a detailed construction schedule, delays in site preparation, and material unavailability during project execution.
Quality Factor	Quality issues in construction projects occur when there is no leadership involvement and quality specifications during the project execution.

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Cost Factor	High construction material costs and poor contract management resulting from a lack of stakeholder engagement contribute negatively to project performance.
Productivity Factor	Productivity factor is negatively impacted by material shortages and the lack of skilled workers.
Contractor Factor	Contractors' Poor project planning and scheduling during construction have a significant impact on construction-related challenges.

2.5 The Defects in the Construction of the Transmission Line Towers

Design defects drive rework, waste, and the Cost of Poor Quality (COPQ) in the construction industry. According to (Abdelalim et al.2025) and (Ayalp 2025), there are various factors contributed to rework, which account for over 70% of the completed designs in construction transmission tower projects. Communication improvement, identifying the design errors and ensuring that the rework is mitigated in the construction projects will result in minimising the rework, efficiency improvement and cost reduction. (Mahinkanda et al.2023) indicated that despite the various studies in minimising the construction waste, it has been proven that the waste minimisation efforts during the construction phase are not adequate and still not given attention in the design phase. Thus, the design phase in construction projects is a critical phase with significant consequences for the project's performance. Therefore, it is critical to implement an oriented approach for the design to minimise construction waste. (Wosasa et al.2025) Indicated that it is challenging to identify the defects in the construction of Transmission lines, the root causes, and to implement the preventive measure is challenging. According to (Karunasena et al.2025), construction defects occur in different project phases, starting from the design phase, planning phase and during the construction.

(Liang et al. 2020) highlighted the defects in the construction of Transmission lines, which have increased the rework and cost of Poor-Quality during construction in Table 3

Table 2 : Transmission line defects

Defect Name	Defect description
Tower foundation defects	Lack of geotechnical investigation resulted in foundation failure and rework in the excavation backfilling.
Insulator defect	An incorrect choice for the insulator resulted in tower foundation strengthening and redesign.
Grading ring defect	The grading ring was not included in the design of the electrical high-voltage transmission line, which resulted in the redesign of the foundation and strengthening.
Contact terminal defect	Terminal for tension level if not specified on the design, that result into rework on tower foundation strengthening
Triple plate defect	The underestimate of the distance edge, with a plate thickness in the design, results in rework, recasting the foundation and strengthening the steel works.
Earth wire defect	Earth wire, if not initially included in the load calculation, results in foundation impact in redesigning and casting.

2.7 Gaps in the Literature

The literature review highlighted the contributing factors to the cost of poor quality in construction projects, and various gaps still need to be addressed. (Fauzan and Sunindijo 2021) stated that various lean tools, practices, principles, and techniques have been adopted in the construction industry and implemented in the manufacturing industry. However, many tools are yet to be fully adopted, lean application principles in the construction industry are still evolving and have not yet reached full maturity as compared to the manufacturing industry. (Olayinka 2015) identified a gap that various authors attempted to quantify COPQ none of them managed to integrate and quantify all the

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characteristics, such as delays, waste, rework, and changes in design. Instead, the emphasis was on the basic features of COPQ, such as non-conformance costs and deviation. (Olayinka 2015) concluded that there is no established methodology for quantifying factors that contributed to COPQ, which makes it difficult to monitor the project performance to come up with a strategy to reduce the COPQ. Therefore, addressing these gaps is important to ensure that there is an established methodology to quantify the cost of COPQ to monitor the project performance. (Singh and Kumar 2021) indicated that there is a lack of coordination between the project stakeholders throughout the project phases; however, the contractors only contributed to the areas of their speciality and handed over the project to the other contractor, hence the communication is not maintained between the project stakeholders, which results in a decline of project value.

3. Methods

The research design for this study adopted the Quantitative analysis, aiming to achieve new insights. In this design, the researcher analysed the quantitative data using SPSS to determine the statistical correlations between the variables, such as re-work cause, cost associated with time delays caused by the re-work and frequency of re-work incidents, to discover valuable insights to improve construction practices and identify the factors that contribute to the poor-quality costs.

4. Data Collection

The secondary data was used from the archived project documentation of the tower foundation project. The extracted data template was designed in Excel to compile rework data from the sources, including flash reports, quality inspection logs, and financial records, detailing all the rework activities. The data were retrieved from the project's electronic database and validated through cross-referencing with audit reports.

5. Results and Discussion

5.1 Numerical Results and Graphical Results

A VARIMAX rotated principal component analysis, variables with a loading less than 0,5 were removed, such as workplace conflict and loadings with more than 0,5 were considered
including:
F1: Construction designs issues
F2: Poor quality in construction
F3: Rework
F4: Lack of resources
F5: Engineering design issues
F6: Technical issues

Figure 1 illustrates the most contributing factors: Construction Design-related factors, construction waste, construction management-related factors, and poor quality. The results show that out of the total four identified Factors, the Construction design-related factor has a frequency of 31, which interprets 31,6% of the total identified factors. This was followed by Poor quality in construction with a frequency of 28, resulting in 28%. Construction waste accounts for the frequency of 27, which accounts for 27.6 % of the 98 average scores of the factors. Construction management-related factors accounted for the lowest frequency of 12, which accounted for 12.2% out of the 98 average scores of identified factors (Table 4, 5 and 6).

Table 4: Factor Analysis

	Component							
	1	2	3	4	5	6	7	8
Communication	,205	-,377	-0,17	,620	-,335	,334	-,051	,033
Construction issues	,903	,101	,001	-,187	-,104	-,116	,180	,160
Engineering Design Issues	,788	,099	-,400	,155	-,022	,024	-,068	,343
Inadequate Training experience	,780	-,198	-,274	,076	,030	-,045	,401	-,035
Lack of instructions	-,389	,490	-,207	,616	,280	-043	,013	,031

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Lack of evidence	,081	,559	,216	,235	,672	,220	,072	,035
Lack of resources	-,298	,576	,361	,606	-,014	-,145	-,088	,083
Lack of supervision	-,378	-,409	-0,19	-,515	,031	-524	,273	-,083
Poor planning	,422	-,338	,024	,516	,281	,528	-,055	,144
Poor quality Engineering work	-,371	-,181	,342	-191	-,505	,329	-238	,311
Quality control	,315	,684	,208	-,118	-,322	,218	,266	,-280
Quality Issues	,007	,687	-,525	-,149	,121	,367	,167	-,004
Quality measurements	-,058	,074	,476	-,278	-,129	,395	-,636	,244
Rework	,609	,048	,152	,284	,315	-,160	-,202	-,305
Teamwork	,233	,360	,664	-,461	,080	-,275	,024	,141
Technical issues	,407	-404	,546	,346	,198	,044	,108	,006
Workplace conflict	,508	,105	-,502	,360	-,313	,018	,162	,240
Construction design issues	,596	,359	,407	,273	-,347	-,048	,102	,317
Construction management factors	,303	-,307	-,075	-,059	,663	,068	,172	-,533
Construction waste	-,173	-,564	,663	,111	,117	,068	,276	-,169

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,451	21,197	21,197	4,451	21,197	21,197
2	3,385	16,121	37,319	3,385	16,121	37,319
3	3,015	14,358	51,677	3,015	14,358	51,677
4	2,615	12,455	64,131	2,615	12,455	64,131
5	1,941	9,244	73,375	1,941	9,244	73,375
6	1,454	6,923	80,298	1,454	6,923	80,298
7	1,170	5,573	85,872	1,170	5,573	85,872
8	1,001	4,767	90,639	1,001	4,767	90,639

Based on the variance explained, 4 factors described more than 60 %.

Table 5. Eigenvalues

Factor	Eigenvalue	Variance	Factors
F1-Construction designs issues	4,451	21,2 %	Design challenges, and technical issues.
F2-Poor quality in construction	3,385	16,1 %	Quality control and lack of supervision
F3-Rework	3,015	14,4 %	Operation efficiency and rework
F4-Lack of training and supervision	2,615	12,5 %	Inadequate training, lack of communication and supervision

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Table 6: Varimax and rotated matrix

Rotated Component Matrix[a]

	Component							
	1	2	3	4	5	6	7	8
CommunicationB	,065	,126	,183	-,623	,574	,110	,111	,018
ConstructionsIssues	-,377	,817	,037	,204	,106	-,131	,190	-,160
EngineDesignIssues	-,444	,722	-,336	,011	,186	-,260	-,066	-,026
Inadequatrainingexp	-,411	,534	,055	-,028	,327	-,119	,061	-,558
LackofInstructions	,764	-,212	-,363	-,064	,160	-,236	-,152	-,159
Lackofevidence	,216	,016	-,256	,874	,172	-,064	-,123	,043
Lackofressources	,942	,034	,046	,000	-,029	-,160	,120	,147
Lackofsupervision	-,423	-,471	-,091	,124	,042	,699	-,131	-,012
PoorPlanning	-,019	,169	,125	-,123	,911	,022	-,216	-,028
PoorQualityEngiwork	,063	,015	,096	-,190	-,167	,832	,028	,265
QualityControl	,192	,323	-,261	,357	,010	,170	,744	-,078
Qualityissues	,106	,047	-,900	,270	,073	,010	,113	-,183
Qualitymeasurements	-,034	,003	,031	,164	,078	,158	,069	,932
Rework	-,072	,111	,085	,261	,781	-,305	,262	,047
Teamwork	,058	,363	,254	,691	-,284	,109	,155	,301
TechnicalIssues	,052	,271	,822	,066	,275	-,135	-,091	-,124
Workplaceconflict	,369	-,121	-,452	-,600	-,157	,179	-,172	-,180
ConstructionsdesignIssues	,300	,830	,142	,032	,178	,062	,321	,135
Constructionmanagementfactors	,027	-,119	,047	,195	,013	,117	-,933	-,102
Constructionwaste	,049	-,277	,788	,094	,187	,412	-,057	-,071
Poorqualityinconstruction	,778	-,125	,095	,281	-,123	,384	,090	-,033

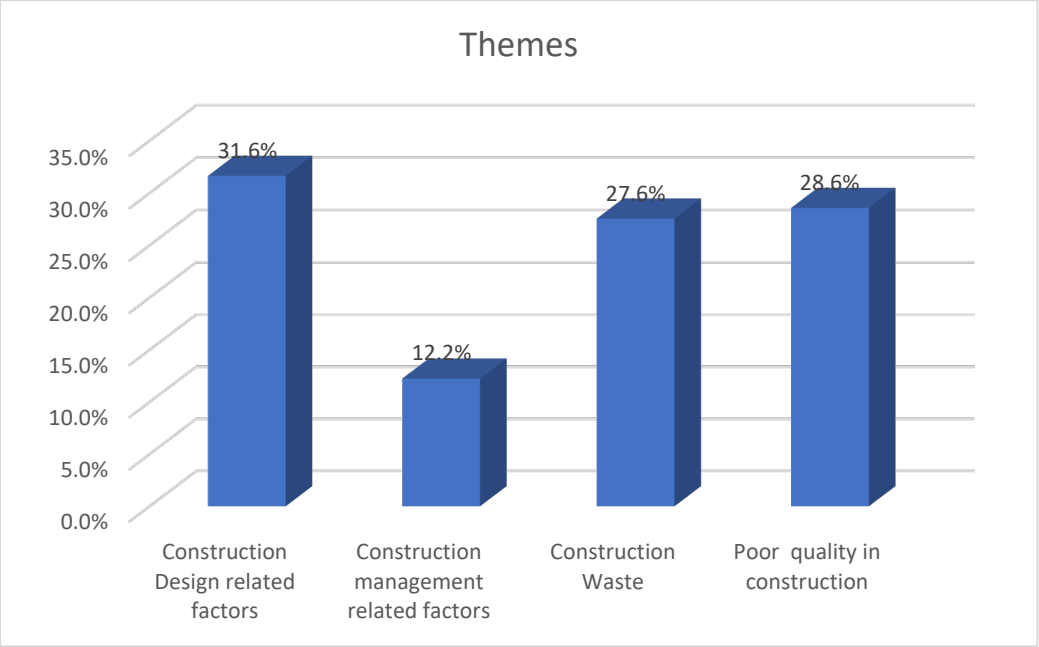

Figure 1: Graphical Representation of the Themes

5.3 Proposed Improvements

Based on the research findings, various proposed improvements have been proposed to reduce the factors that contributed to the COPQ in the Construction Industry.

Construction Design-related factor-Contractors, suppliers, Procurement, project managers, and construction planners should be involved in the early design phase of the project to ensure the constructability and feasibility of the project. Furthermore, improving the technical ability of designers in the construction industry can further reduce design errors and other related construction rework costs.

Construction Management-related factor- researcher recommended project management improvement on the construction schedule, implementation of quality control procedures, and ensuring effective communication among the project stakeholders to minimise rework and improve performance.

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Construction Waste Factor- For the construction waste elimination, the researcher recommended the lean construction implementation practices to improve the management of materials. This includes procurement timelines, training and awareness sessions for project stakeholders to ensure they understand the waste reduction targets for the organisation and integrating the minimisation of design errors and waste that can significantly reduce rework costs to improve project performance.

Poor Quality in Construction-To reduce the cost of poor quality in the construction industry, the researcher recommended that organisations to implement a well-structured quality management framework that highlights cost prevention over improvement. This includes root cause analysis, indicators of COPQ, improvement techniques implementation and investigation of employee training that leads to rework reduction.

6. Conclusion

The research objective was to identify the factors that contributed to COPQ and project performance in a South African construction company. The findings revealed the top four (4) most contributing factors that contributed to poor quality cost in construction projects in South Africa. The results depicted in Figure 1, the researcher concluded that there is a need to assess the critical factors impacting the cost of quality in construction. The researcher concluded from the study that the most severe factors affecting project quality in construction company are Construction design-related factors, Poor quality factors, Construction waste industry and Construction management-related factors. The analysis of the study discovered in Figure 1: Construction design-related factors accounted for the highest percentage of 31,6% of the total identified factors that resulted in the cost of poor-quality.

Poor quality in construction has the second-highest percentage of 28% out of 98 average scores of identified factors. Construction waste was the third highest, accounting for 27.6 % out of the 98 average scores of the factors.

Construction management-related factor accounted for the lowest percentage of 12.2% out of 98 average scores of identified factors. The analysis ranked the factors from the highest contributor to the lowest and provided a comprehensive understanding of the key contributors to the COPQ in the construction industry.

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Professor Dr Kgabo Mokgohloa is a scholar, Ubuntu coach, strategist, and thought leader whose work bridges academia, leadership development, and organisational transformation. With extensive experience in higher education, research, and executive practice, he is committed to advancing knowledge and practice in systems thinking, systems engineering, systems dynamics, personal mastery, value management and value engineering, strategy formation and execution, sustainability, sustainable engineering, digital strategy, digital innovation, digital disruption, coaching, mentoring, and human-centred leadership. As an academic, Prof. Dr Mokgohloa has published extensively in journals and conference proceedings and has contributed significantly as a reviewer, editor, and researcher in the fields of technology, strategy, and sustainability. He has served as an Honorary Treasurer and Council Member of the Southern African Institute for Industrial Engineering (SAIIE) and as an Associate Editor of the *Technology Analysis & Strategic Management Journal*. Beyond academia, he is the founder of Dr Kgabo Coaching Clinic, a practice grounded in Ubuntu philosophy that supports organisations, leaders, teams, postgraduate students, and individuals through coaching, facilitation, and foresight initiatives. His approach combines African wisdom traditions, including the symbolism of the baobab tree, with contemporary methodologies such as systems thinking, strategic foresight, and Sun Tzu's *Art of War*. Prof. Dr Mokgohloa is also the author of the novel *Unchained*, a speaker, and a respected advocate for leadership transformation. He holds qualifications in Chemical Engineering, Industrial Engineering, Environmental Engineering, and a PhD in Industrial Engineering, as well as an International Coaching Federation (ICF)-accredited Ubuntu Coaching Programme certification.

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